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SHRIMP: HANDLING, TRANSPORTATION, AND USES.

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That both raw and cooked shrimp can be shipped to distant markets without the use of preservatives and arrive in good condition is established both by the experience of careful packers and by the investigations reported in this bulletin. To do this, however, the handler must observe two precautions. In the first place, he must keep raw shrimp iced or cold from the time they are caught until they reach the consumer. Secondly, he must wash the raw shrimp thoroughly, as soon as possible, in order to remove slime and foul stomach contents which are likely to contaminate the product and give it an unsatisfactory color or flavor after it has been cooked. Careful handling is necessary at every stage to avoid unnecessary breaking or damaging of the shrimp.

ICING.

Unless they are iced or cooled immediately when caught, shrimp will soften quickly, especially in warm weather. Whenever there is danger of such softening, shrimp boats or trawlers should carry plenty of ice. Shrimp buyers should refuse to take stock that is not in good condition at the dock. Heavy icing is particularly important when the shrimp are molting, because then they are soft, easily broken in handling, and more subject to decomposition.

Care in handling shrimp properly begins the moment the net is raised. All soft, damaged, or small shrimp should be culled out and

the slime and dirt removed by thorough washing with water. Culled and cleaned shrimp should be stored in the boat at once with cracked ice. As soon as the boat reaches the dock the shrimp should be removed from the hold, sorted a second time, and weighed. Unless the stock is to be headed at once, or is to go immediately to the kettle, the shrimp should be placed in cooling tubs filled with cracked ice and water, or go into a refrigerated room, the temperature of which is below 40° F., and allowed to stand there for several hours until completely chilled. When shrimp are to be shipped raw they should always be thoroughly chilled before shipment. If the chilling is thorough, less ice will be required in transit and the stock will be firm when delivered.

HEADING.

In certain sections the trade demands headless stock. In other markets, especially in the South, consumers are suspicious of headed shrimp, as they erroneously regard the absence of the head as an indication of spoiled stock. Such consumers ultimately pay the express on the entire weight of the package and then throw nearly half of the shrimp away. Experiments indicate that the heads and appendages constitute from 43 to 45 per cent of the raw whole stock and about 41 per cent of the cooked whole stock.

It is essential that the shrimp be headed before they have become warm, because the dark liquid in the stomach of the shrimp consists of oily, partially digested plant and animal material, which readily decomposes. This liquid, as well as the body slime, must be removed immediately after the shrimp are headed.

COOKING.

THE BRINE.

The crude, haphazard methods of cooking practiced in some plants explain in large part the losses in cooked shrimp and the unpalatability of some products. Such "rule-of-thumb" methods as cooking until the meat pulls away from the back of the shell will not give uniform results. The careful packer when cooking seeks to sterilize the shrimp by the heat and to let the stock absorb enough salt from the brine to insure proper seasoning and to promote keeping qualities. At the same time the packer must control his operation so as to prevent excessive loss in weight from overcooking and loss in quality from undue hardening and salting of the meat. Undercooking is also to be guarded against, as it results in a flabby, tasteless product, poor in keeping quality.

The initial step in cooking first-class stock is to use brines of proper strength. No definite rules can be laid down as to the strength

of the brine, as this will depend on the relative amounts of shrimp and brine used, the time allowed for cooking, and the degree of saltiness desired. Each packer, by experiment, can determine readily the strength of brine and the length of cooking which will yield the results he desires. In general, the brine should contain not less than 10 per cent, by weight, of salt and not more than 25 per cent. There should be at least 4 gallons of brine for each 10 pounds of shrimp. The careful packer will equip himself with a hydrometer so that he can measure accurately from time to time the density of his brine.

THE COOKING VESSEL.

The shape of the vessel in which the shrimp are cooked directly affects the evaporation of water from the brine, and consequently has a bearing on the density of the brine during cooking. Deep kettles with straight sides that have as little surface as possible for loss of heat and for evaporation, are the most satisfactory. They should be heated from some constant source—preferably coils of steam pipes immersed in the brine—which permits of exact control of temperatures. It is not desirable to cook shrimp in metal tubs, in pots, or in wide, shallow kettles over open fires.

LENGTH OF COOKING.

It is very important to have the brine actually bubbling before any shrimp are put into the kettle. Cold shrimp will chill the brine so that it stops boiling, but if the volume of liquid is sufficiently large, active boiling will be resumed within a few minutes. Since the shrimp in cooking develop air spaces and rise to the surface, they should be held down by a weighted wire screen or similar device to insure proper cooking.

The length of cooking depends upon the strength of the brine, the quantity of shrimp to be cooked, and the flavor desired. In general, shrimp are cooked from 15 to 20 minutes after the brine in which they have been placed begins to boil. The shorter the cooking and the weaker the brine the less will be the shrimp's loss in weight. When a minimum amount of salt is used, continuous refrigeration is necessary in order to prevent spoilage, and the product is suitable only for shipping to near-by markets. Shrimp that will be shipped to distant markets should first be cooked in 15 per cent brine for 15 to 20 minutes, cooled in a chill room to 35° F., or less, and then shipped in a sealed package surrounded by ice,.

ACCURATE CONTROL OF COOKING.

To insure accurate cooking, the packer should use a thermometer which registers as high as 250° F. It should be made entirely of glass, as brine affects wood or metal frames. The packer should also have

a hydrometer graduated in salt percentages, Baumé scale, or specific gravity. Hydrometer readings should be taken only in cool brines, the temperature of which is as near 60° F. as possible. With these instruments the packer can determine readily by a few experiments the best brine and the best temperature as related to time of cooking. Cooking for 15 minutes in a 15 per cent brine might be used as a starting point in these experiments.

The following table shows the approximate relationship between the boiling points, densities, and specific gravity of the brines, and the amounts of salt needed to make a brine of given percentage. In ordinary practice, however, it is necessary to have from 10 to 20 per cent more than the specified amount of salt. As commercial salts vary in impurities and moisture content, this table is suggested only as a guide. It must be modified after experiment to fit the particular salt used.

TABLE 1.—*Approximate relationships between boiling points and strength of brine.*

Salt.	Boiling point of brine.	Specific gravity of brine at 60° F.	Density of brine at 60° F.	Dry salt required for 100 gallons of brine.
Per cent.	*° F.*		*° Baumé.*	*Pounds.*
5.0	214	1.035	5.0	43
7.5	216	1.054	7.4	65
10.0	217	1.073	9.8	86
12.5	219	1.092	12.2	113
15.0	221	1.112	14.5	139
17.5	223	1.131	16.7	165
20.0	225	1.152	19.0	191
25.0	228	1.192	23.2	230

COOKING WITH LIVE STEAM.

Live steam, occasionally used for cooking headed shrimp that are intended for drying, may also be employed in cooking shrimp for ordinary purposes. The shrimp are sprinkled evenly with salt and allowed to stand a short time. They are then placed in a steam-tight box and subjected to the action of live steam for half an hour. This process, aside from obviating the necessity for making and handling brines, requires less salt, prevents soaking out of flavors, and results in less loss in weight. Where brine is used, chemical analysis of the scums and brines after cooking shows that considerable amounts of albuminous and mineral matter have passed from the shrimp into the brine. The albumin coagulates upon boiling in much the same manner as does the white of an egg. This loss in albuminous and mineral matter means that the shipper loses, since he has fewer pounds of shrimp to ship, and that the consumer does not receive the full food value of the product.

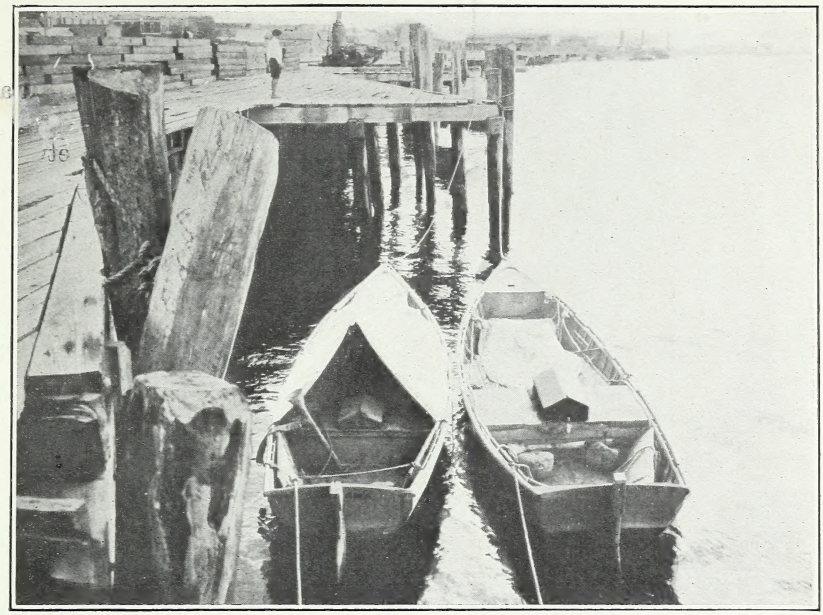

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FIG. 1.—TRAWL NET BOATS USED FOR CATCHING SHRIMP.

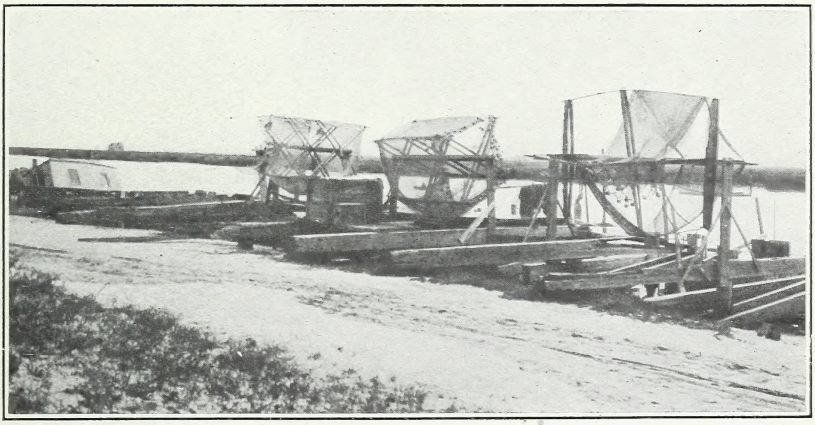

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FIG. 2.—SHRIMP IN SHALLOW WATER ON THE BEACHES ARE CAUGHT IN THESE LONG NETS BY WADING MEN.

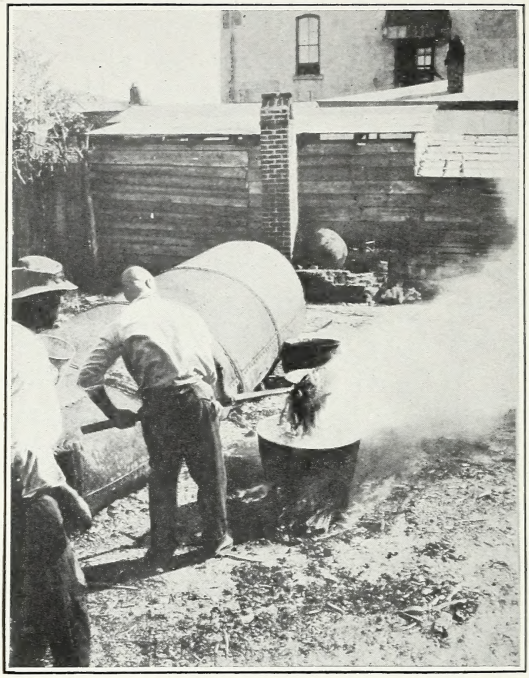

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FIG. 1.—BOILING SHRIMP OVER OPEN FIRES BY "RULE-OF-THUMB" METHODS IS LARGELY RESPONSIBLE FOR THE LOW QUALITY SHRIMP SOMETIMES FOUND IN NORTHERN MARKETS.

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FIG. 2.—SHRIMP HEADS. A VALUABLE FERTILIZER NOW GOING TO WASTE.

PREPARING COOKED SHRIMP FOR MARKET.

COOLING SHRIMP AFTER COOKING.

After they have been cooked the shrimp should always be cooled thoroughly before being packed for shipment. Unless this cooling is done properly they can not be shipped to market successfully. The spoilage of shrimp in transit is due more to incomplete chilling before packing than to any other single factor.

The shrimp should be placed in thin layers on cooling racks of wire screens in a temperature below 50° F., if possible, and exposed to a free circulation of air. Under this treatment the shrimp quickly lose their heat and the excess of water absorbed from the brine. The packer should not judge their temperature merely by touching the shells. Cooked shrimp contain air spaces between the meat and the shell and as the shell is a poor conductor it frequently is cold to the touch even when the shrimp meat itself is still warm. The degree of cooling may be tested by removing a shell and breaking open the meat.

In the Southern States the temperature of the air may be from 75° to 90° F. This is too warm to cool the shrimp to the degree necessary in the case of such a perishable foodstuff. Under such conditions the shrimp must be placed in a refrigerated room. Proper cooling is of the greatest importance because it means less danger of spoilage in transit, results in the use of less ice in packing, and insures freshness in the product when it reaches the market.

PACKING COOKED SHRIMP FOR SHIPMENT.

There are several ways to pack shrimp, depending on the demands of the markets and the distances to which the shrimp are shipped. For near markets whole or headless cooked shrimp are packed in small boxes or crates and shipped in the cool months, usually without refrigeration. The containers should not hold over 30 pounds, as a larger bulk increases the danger of heating. Unless the shrimp are absolutely dry and cooled to a temperature of less than 40° F. it is hazardous to ship them in air-tight containers because of danger of sweating and consequent decomposition. For this reason some packers use ventilated containers or crates.

Dry cooked shrimp are thoroughly cooled, packed, and sometimes shipped in 1 to 5 gallon tin cans that are lined with paper and provided with water-tight covers or tops which are soldered or fastened tightly to the can. The sealed cans then are packed in ice in burlap-covered barrels with drainage holes at the bottom. Such packages are reiced by the express company when necessary, and even in warm weather can be transported in good condition.

Some shippers pack the cooked stock in tight cans in light brine supposed to act as a preservative. The dry-packed stock, however,

has a better flavor and keeps just as well if it has been properly cooked and handled. Packing brines should not be over 5 to 10 per cent strength. Heavier solutions tend to make the shrimp leathery and too salty and weaker ones produce softness and flabbiness in the stock and have no appreciable preservative effect. A brine of 7 or 8 per cent strength should be satisfactory for shipping purposes. In such packing both shrimp and brine should be cooled before shipping; otherwise there is danger that the ice may melt during transit and the shrimp consequently decay.

Headless cooked shrimp packed in kegs in strong brine of from 15 to 20 per cent strength keep very well. This "keg stock" sometimes is used in restaurants or hotels, where the necessary freshening can be done. Most housewives prefer the product packed in weak brine because it is more convenient and has a better flavor.

PACKING RAW SHRIMP FOR SHIPMENT.

Raw shrimp before being packed are chilled with ice to 40° F. or below. A layer of ice is placed in the bottom of a barrel provided with drainage holes. A layer of chilled shrimp is placed on the ice, then another layer of ice, and more shrimp. A large cake of ice or "header" is placed on the top of the barrel. Another method is to provide a bottom layer of ice and then place on end in the center of the barrel a long, narrow cake of ice. The shrimp are packed around this cake, or core, of ice, the "header" cake is placed on top of the barrel, and the barrel and its contents covered with burlap. Cooked shrimp, as a rule, are sent by express in small lots. In the case of raw shrimp, car lots of iced barrels occasionally may be shipped by fast freight in refrigerator or ventilator cars.

DRIED SHRIMP AND OTHER SPECIALTIES.

Dried shrimp are prepared in certain sections of Louisiana and Florida. The cooked shrimp are dried outdoors in the sun and the meats threshed out from the shells. Under an improved process raw shrimp sprinkled with salt are cooked with live steam and dried over steam pipes. This rapid drying results in a bright, attractive food product which has not been subjected to the molding or decomposition frequently taking place when shrimp are dried outdoors under varying weather conditions. This product deserves a wider market.

Headed and peeled shrimp meats also should prove popular. These meats after being cooked in a weak brine are cooled and dried on wire screens. They are then packed dry in tightly sealed tin cans (sometimes lined with paper) of from 1 to 5 gallon capacity. The cans are shipped in barrels of cracked ice.

Shrimp pastes are prepared by grinding shrimp meats and adding salt and flavoring. They are used like anchovy paste for sandwiches

and as a relish. Potted tuna fish, smoked salmon paste, and similar preparations of halibut have recently met with some sale in this country. It is believed that a somewhat similar by-product can be made profitably from broken or small shrimp or from surplus stock taken in periods of slack markets.

FOOD VALUE OF SHRIMP MEAT.

Chemical analysis shows that shrimp are a nitrogenous food containing constituents similar to those found in cheese, meat, oysters, and eggs. Almost all of the edible portion of raw shrimp is protein, the muscle and tissue building food element. Since shrimp are a concentrated nitrogenous food they may be used as the principal dish of a meal as well as the basis of a salad or as an appetizer or relish.

Table 2, which shows the results of analyses of shrimp obtained from different localities and prepared in various ways, gives comparisons between shrimp and other foodstuffs of a nitrogenous nature.

TABLE 2.—*Analyses and food values of shrimp and certain other foodstuffs.*

[Calculated on the fresh basis.]

Constituents.	Shrimp (edible portion).				Other foods (edible portion).							
	Cooked.	Canned (dry packed).	Canned (wet packed).	Dry.	Scallops.	Oysters, shucked.	Canned salmon.	Fresh halibut.	Whole egg.	Beefsteak, lean.	Whole milk.	American cheese.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Protein	27.6	25.5	20.0	71.4	14.8	6.2	21.8	18.6	13.4	21.3	3.3	28.8
Carbohydrates	.....	.....	.....	.....	3.4	3.7	.....	.....	.....	.....	4.0	.....
Fat	1.0	0.8	0.5	5.0	.....	1.2	12.1	5.2	10.5	7.9	5.0	35.9
Water	64.5	67.7	75.7	12.5	80.3	86.9	63.5	75.4	73.7	70.0	87.0	31.6
Salt	4.8	2.9	1.9	6.8	.....	.....	1.0	.....	.....	.....	.....	1.7
Comparative fuel value per pound (calories)	559	505	395	1,540	345	235	915	565	720	730	325	2,055

UTILIZATION OF SHRIMP WASTE.

When shrimp are headed about 43 per cent of their weight is thrown away. Small amounts of this material are used locally by farmers, who report that it has excellent fertilizing value for certain crops. As a thousand barrels of shrimp (50,000 to 60,000 pounds) are landed sometimes in a single day it is obvious that a large amount of potentially valuable fertilizing material is obtained from the heading of shrimp. Some attention has been given to the drying of shrimp heads for sale as fertilizer. Experiments indicate, however, that in the process of drying a large amount of nitrogen is lost in the form of ammonia or other volatile substances. To retain this nitrogen it would seem advisable to mix the material before drying with a suitable acid-reacting substance of value as a fertilizer. The material

when dried in this manner should constitute a valuable by-product. Analysis shows that dried shrimp waste contains over 11 per cent nitrogen, calculated as ammonia, and 2½ per cent phosphorus, calculated as phosphorus pentoxid. These figures indicate high fertilizing value.

SUMMARY.

Cleanliness, proper cooking, and care in handling shrimp, combined with a discontinuance of the practice of using preservatives, have resulted in the production of a finely flavored product which is gradually increasing in popularity. At the same time improvements in methods of packing and preparation have made shrimp accessible to many new markets at long distances from the producing sections.

Packers in the South and on the Pacific Coast should make every effort to keep their own products up to the highest standard and should do everything possible to promote the general adoption of high standards by the trade.

The increased consumption of shrimp and the opening of new markets are stimulating the industry to increase its catches. If shrimp are taken at the wrong time of year or in excessive numbers their extermination is probable. Those interested in the shrimp industry, therefore, should give early attention to the question of conservation. It is also to the interest of those whose livelihood is dependent upon catching and packing shrimp to encourage investigations planned to determine the periods of spawning, the times of migration, and the feeding habits of shrimp, and to do their part in helping to make such investigations result in the adoption of protective measures.

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